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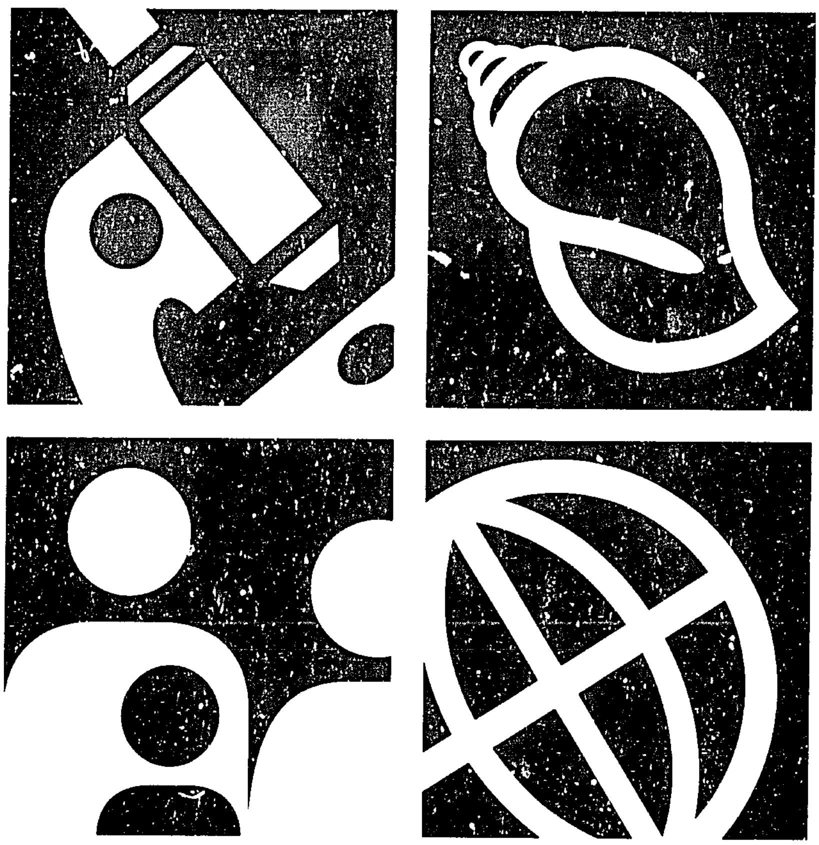
SCHISTOSOMIASIS



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SCHISTOSOMIASIS

by

John I. Bruce, Ph.D.

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Life cycle illustrations: *Taina Litwak*
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The blue square shows a snail of the genus **Bulinis**, *which is the intermediate host for* **Schistosoma haematobium**. *The other symbols depict essential components of vector-borne disease control: the environment, communities and research.*

Author

John I. Bruce, Ph.D., is the Director for the Center for Tropical Diseases at the University of Lowell in Massachusetts.

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Table of Contents

Figures

Maps

Annex

Executive Summary

Schistosomiasis is a chronic debilitating disease that is estimated to affect between 200 and 300 million people in 79 countries. As many as 600 million live in endemic areas. Infection with any of the five species of schistosome worms is rarely fatal, but the resulting organ damage is progressive, leading to chronic illness and complications in adult life.

First infection with schistosomiasis usually occurs during the early school years and is a frequent cause of absenteeism. It is not uncommon for 85 percent of a school's student population to be infected in some highly endemic areas in Africa.

In addition to its effect on children, schistosomiasis has a major impact on the agricultural workforce and on national economic productivity. In Egypt, where 20 percent of the people are infected, economic losses due to lost work are estimated to exceed $500 million a year.

Freshwater snails serve as intermediate hosts for the parasite. The larvae of the parasite penetrate the unbroken skin of humans who enter the water in which infected snails live. The cycle is continued when people infected with schistosome worms deposit urine or fecally borne eggs into the water.

Development, both planned and unplanned, has resulted in a number of changes in the epidemiology of the disease that threaten to expand the infected population, reduce productivity and minimize development gains. Water development schemes, including dam building and irrigation systems, have created new breeding sites for snails. Intensive agriculture has encouraged people to migrate to urban and peri-urban areas that are ill-prepared to meet their needs for sanitation and water. In these areas, snail-infested streams and canals are often the most convenient water sources. New agricultural systems that emphasize irrigation, double cropping and other intensive cultivation practices have increased farmers' exposure to infection.

Praziquantel, a safe, single-dose, oral medication for all species of schistosome, was introduced in the early 1980s and is now the primary tool for controlling the disease. Recent reports about its reduced efficacy in localized situations have raised concerns about tolerance or perhaps resistance. Significant control of schistosomiasis also can be achieved through environmental improvement, increased sanitation, and provision of safe water.

1.0 Introduction

Schistosomiasis, or Bilharziasis, is a disease that affects an estimated 200 to 300 million people in 75 countries of Africa, Latin America, Asia and the Middle East. It is caused by flatworms or flukes of the genus *Schistosoma*. The disease is transmitted to humans when they enter water contaminated with infected freshwater snails, which serve as intermediate hosts of the parasite.

The morbidity associated with schistosomiasis results from the mechanical and toxic irritation caused by eggs lodged in blood vessels and by granulomata, which are localized tissue reactions to eggs. As the immune system recognizes the egg as a foreign body and tries to destroy it, scar tissue develops around the egg, forming a granuloma.

There is a direct relationship between the number of eggs in tissues and the severity of symptoms. The numbers of eggs are, in turn, directly proportional to the total worm burden and the duration of the infection. For those who experience a daily infection over a period of several years, the total worm burden may be enormous. People who enter snail-infested waters infrequently may be lightly infected and completely asymptomatic. The type of pathology experienced by an infected individual is also a function of the location of the egg-producing worms, which varies with the species of schistosome.

Some of the more common pathological changes seen in chronic schistosomiasis infections include bleeding into the intestine or urinary system, liver enlargement, periportal (symmers) fibrosis and spleen enlargement. Other conditions associated with the disease are heart enlargement due to decreased blood flow through the lungs, and esophageal varicose veins that rupture and bleed. A connection between the chronic urinary form of schistosomiasis and bladder cancer is suspected.

a. Agents

There are five species of schistosomes known to infect humans with sufficient regularity to be considered human diseases: *Schistosoma mansoni*, *Schistosoma japonicum*, *Schistosoma haematobium*, *Schistosoma mekongi* and *Schistosoma intercalatum*.

Two forms of schistosomiasis infection are recognized in humans: urinary schistosomiasis caused by *Schistosoma haematobium* and intestinal schistosomiasis caused by *S. mansoni*, *S. japonicum*, *S. mekongi* and *S. intercalatum*.

With *S. haematobium*, the major pathologic lesions occur in the wall of the urinary bladder, often extending to the ureter, kidney, urethra and genitalia. The most conspicuous early sign of this disease is blood in the urine, which tends to subside or even disappear as the lesions become advanced. Frequency, incontinence and pain upon urination are constant and increasingly distressing factors. Lower abdominal pain, bladder colic, and weakness also are characteristic of this disease.

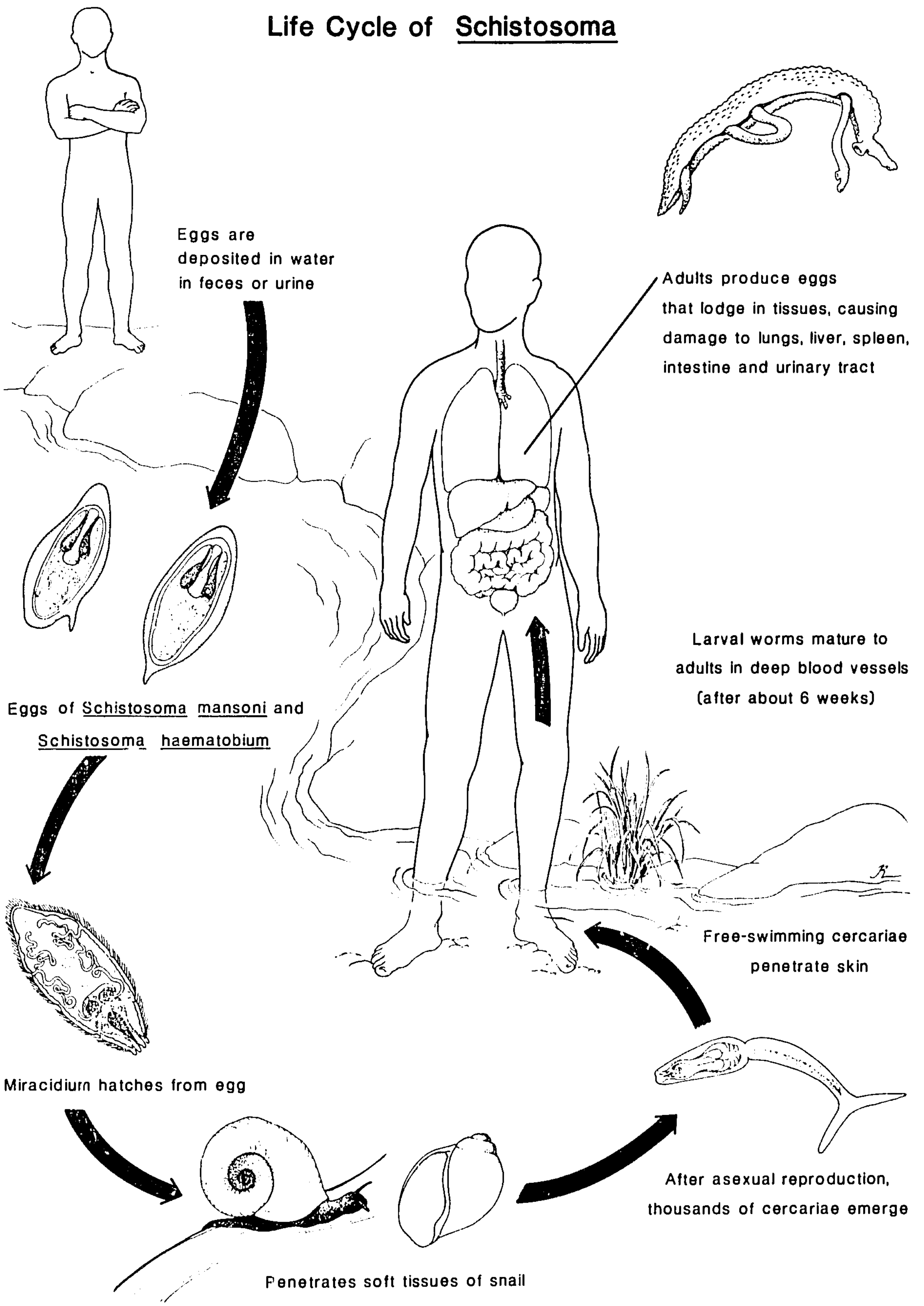
The major pathological lesions for infections with *S. mansoni*, *S. japonicum*, *S. mekongi* or *S. intercalatum* initially occur in the wall of the intestine, particularly the cecum, colon and rectum. Dysentery accompanied by abdominal pain is quite often a severe complication. Enlargement of liver and spleen, as well as arterial obliteration in the lungs, are late complications that may have secondary effects upon the heart. *S. japonicum* is generally considered the most serious of the species responsible for intestinal schistosomiasis, primarily because this species produces more eggs.

A generalized life cycle of *Schistosoma* is illustrated on p. 4. Schistosome worms enter the human body as forked-tailed larvae, or cercariae, which actively penetrate the unbroken skin of people who venture into water in which these larvae are suspended. The human host may experience itching and rash after the larvae has penetrated the skin. If the numbers of penetrating larvae are exceptionally large, the person may develop pulmonary symptoms as the larval worms migrate through the lungs. This stage is accompanied by shortness of breath and cough, and, on rare occasions, an intense, acute and sometimes fatal immunological reaction known as Katayama syndrome.

Adult schistosome worms are found in pairs within the deeper blood vessels of the human body. The females produce eggs, which are passively transported by the bloodstream to the tissues of the body. The majority of the eggs become lodged in the intestine, bladder, liver and spleen.

A small percentage of the eggs are extruded into the lumen of the urinary system or the intestine and are eliminated with the urine or feces. When those eggs are deposited into fresh water, they hatch, releasing thousands of highly motile, ciliated larvae called miracidia.

Life Cycle of Schistosoma



b. Intermediate hosts

The life cycle within the snail is the same for all schistosome species. The miracidium actively searches out its specific snail host, penetrates snail tissue, changes into a mother sporocyst and gives rise to a daughter sporocyst. This sporocyst migrates to the digestive gland or reproductive organ, where further multiplication occurs and a new larva, the cercariae (the stage infective to man), is produced. It takes approximately four weeks at 26-28 °C for the miracidium to produce cercariae within the snail body. After maturing, the cercariae emerge from the snail and enter the surrounding water. One miracidium produces several thousand cercariae.

Freshwater snails are considered the intermediate hosts of schistosome infection, rather than vectors, because transferring the infection requires no physical contact between man and snail.

Many of the intermediate host species, whether aquatic or amphibious, are highly resistant to drying and may repopulate an environment in as little as 50 days after desiccation.

Snails of the genus *Biomphalaria* serve as the intermediate hosts of *S. mansoni* in Africa, southwest Asia, and the Americas. Snails of the genus *Bulinus* serve as the intermediate hosts for *S. haematobium* in Africa, Southwest Asia, and Europe, as well as for *S. intercalatum* in Africa. The genus *Oncomelania* serves as the intermediate host for *S. japonicum* in Asia, while *Tricula aperta* serves as the intermediate host for *S. mekongi* in Southeast Asia.

c. Biogeography

The world distribution of infection with the five species of schistosome includes 200-300 million residents of 79 countries. An estimated 600 million people are at risk of infection.

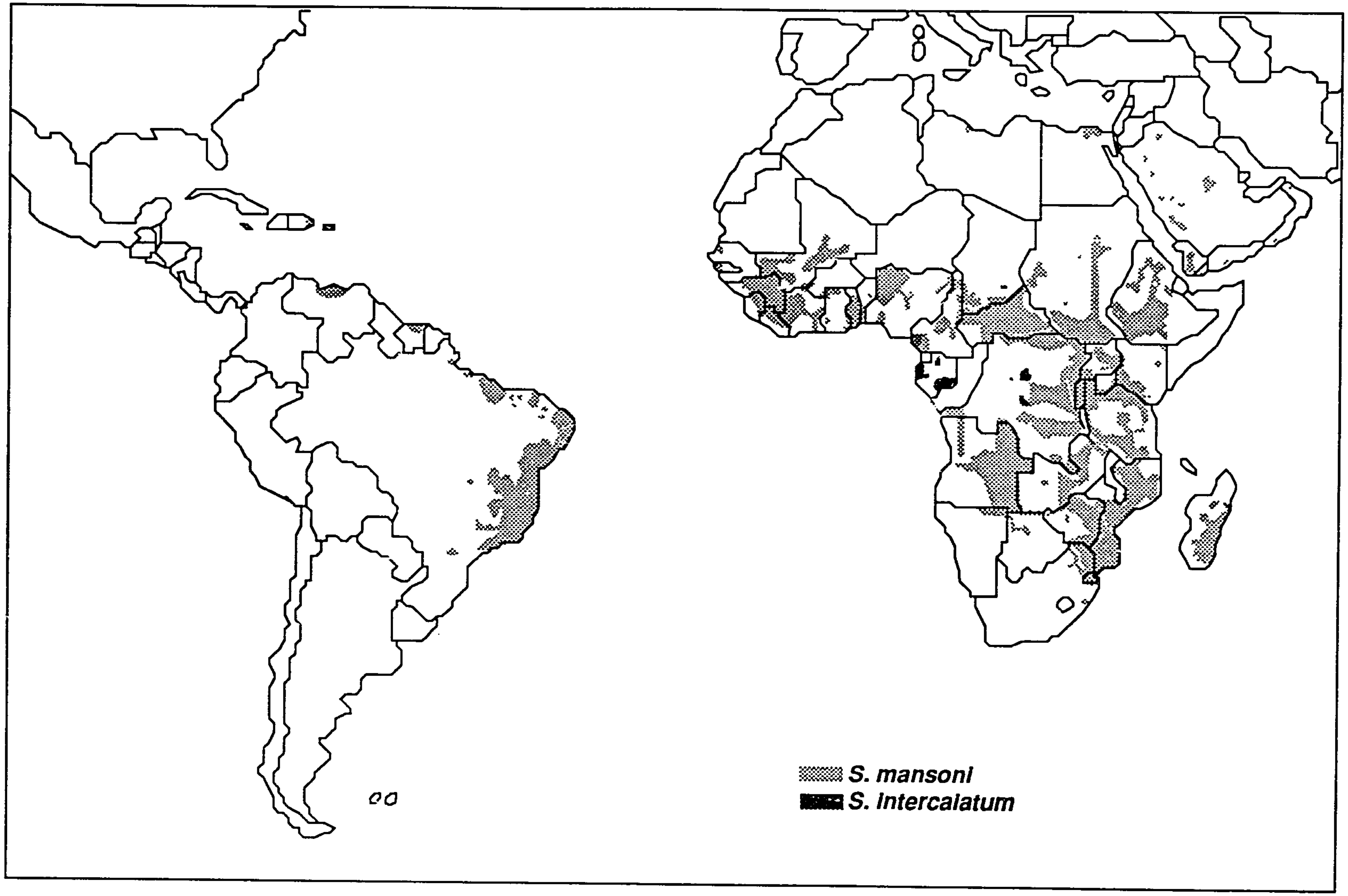
S. mansoni occurs in 53 countries of Africa, the Middle East, South America and some islands in the Caribbean. *S. haematobium* is endemic in 53 African and Eastern Mediterranean countries. *S. mansoni* and *S. haematobium* are co-endemic in 40 countries of Africa and the Middle East. *S. japonicum* occurs in the People's Republic of China, Indonesia and the Philippines, while *S. mekongi* is endemic in two Southeast Asian countries. Small foci of *S. haematobium* are reported in India and Portugal.

More recently, the parasite has been reported to occur in agricultural areas in Sao Tome and Principe, Jordan and Oman.

d. Reservoir hosts (non–human)

Various species of animals are found naturally infected with species of schistosomes that commonly infect humans. In the Orient, dogs, rats, cattle, pigs, sheep and goats are important in perpetuating human infections with *S. japonicum*. Primates are found naturally infected with *S. haematobium*, but their role in the epidemiology of human disease is not considered a strong one.

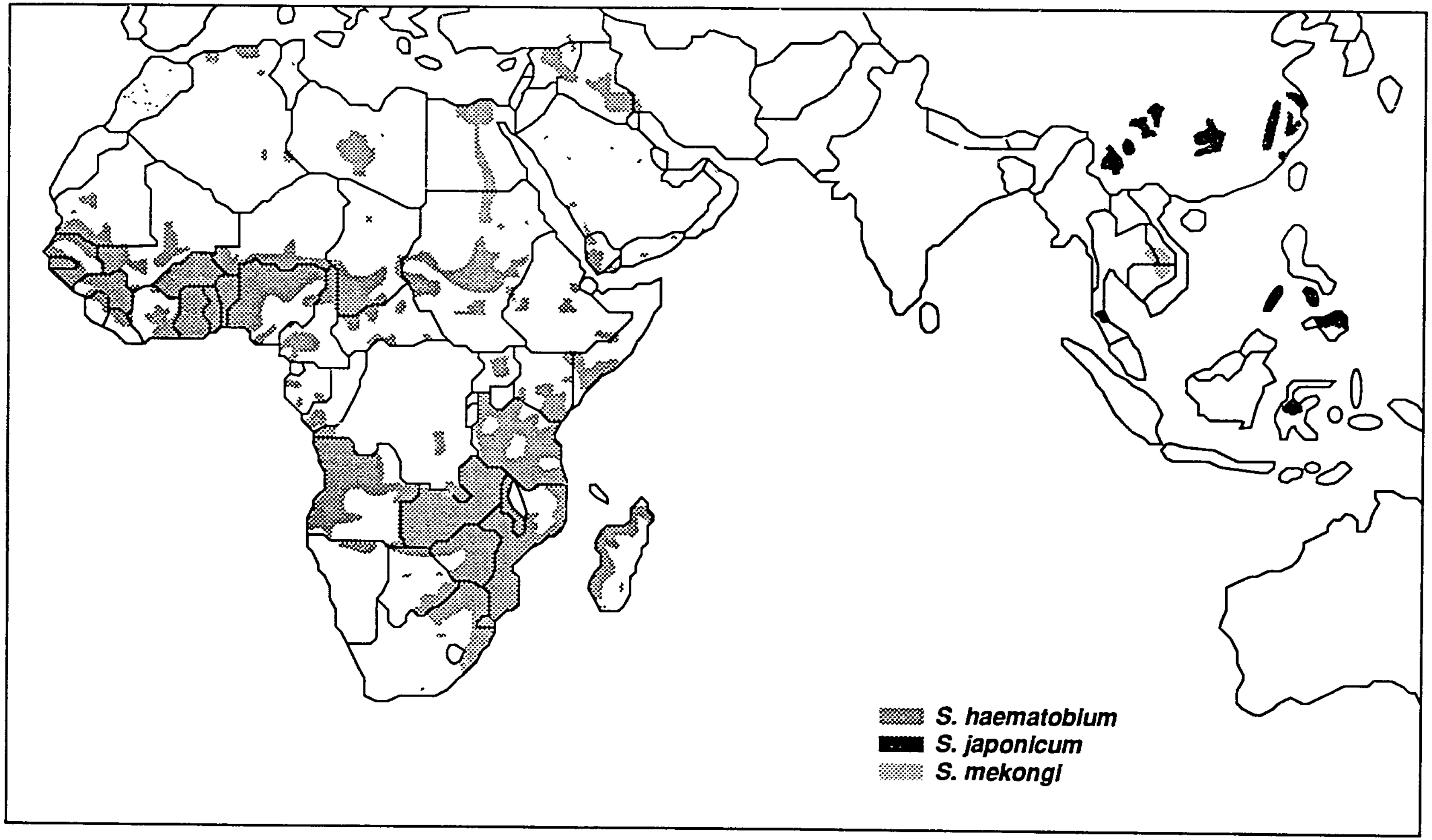
Map 1. Distribution of Schistosomiasis due to *Schistosoma mansoni** and *S. intercalatum*



Prepared by the Vector Biology and Control Project
Source Map: World Health Organization, 1985

* *S. mansoni* is also found in Puerto Rico, St. Martin, Suriname, Montserrat, Antigua, St. Lucia, Guadeloupe and Martinique.

Map 2. Distribution of Schistosomiasis due to *Schistosoma haematobium* and *S. japonicum*



Prepared by the Vector Biology and Control Project
Source Map: World Health Organization, 1985

2.0 Distribution and Severity

The schistosome species known to infect man are widely distributed. *S. haematobium* and *S. mansoni* are found throughout Africa. In North Africa, *S. haematobium* occurs in Morocco, Algeria, Tunisia, Libya, Egypt and Mauritius. *S. mansoni* is highly endemic in Egypt and there is a small focus in Libya. Both *S. haematobium* and *S. mansoni* have overlapping endemicity in almost all other African countries, but *S. haematobium* is often more widely distributed.

In Asia, *S. mansoni* occurs in Southwest Asia, Yemen, South Yemen, Saudi Arabia and Oman. *S. haematobium* is reported in South Yemen, Saudi Arabia, Yemen, Lebanon, Syria, Turkey, Iraq and Iran, with one focus in Maharashtra State in India and one in Portugal. The focus in India represents the only occurrence of this species in South Central and Southeast Asia, but it is possible that other foci may be undetected.

S. mansoni is the only species found in the Americas. It occurs in the Dominican Republic, Puerto Rico, Venezuela, St. Martin, Suriname, Montserrat, Antigua, St. Lucia, Guadeloupe, Martinique and Brazil.

In Africa, *S. intercalatum* occurs in localized foci in Zaire, Gabon, Cameroon, Central African Republic, Nigeria and the Congo. *S. mattheei*, a schistosome parasite of animals, has been reported in humans in South Africa and Swaziland.

The oriental schistosome, *S. japonicum*, occurs in the Philippine Islands, the People's Republic of China, and Celebes, Indonesia. Transmission apparently no longer occurs in Japan, but there are still a few areas where the snail host can be found.

In Southeast Asia, *S. mekongi* occurs in Laos, Cambodia and scattered areas of Thailand. An *S. japonicum*-like parasite has been found in humans in Malaysia.

The distribution of schistosomiasis is far from static. The disease has probably escaped detection in many localities where health services and disease surveillance are not well developed. Several factors contribute to changing patterns of endemicity, including human migration, shifts in agricultural emphasis toward irrigation, intensive water resource development activities, and environmental destabilization.

Examples of recent changes in schistosomiasis transmission include the Jordan River Valley, where development activities are creating new habitats for snails and new patterns of water use, and the Senegal River Valley, where a saltwater intrusion dam has desalinized a significant portion of the river by eliminating seawater backflow. The freshwater habitat created by the dam is a perfect breeding site for intermediate host snails. Peak labor needs of the Gazira Irrigation Scheme on the Nile in Sudan have attracted a large number of susceptible workers into this endemic zone. When the need for their labor is over, the infected workers return to their homes with acquired infections and establish new endemic centers.

a. Number of cases

In Egypt, an estimated 20 million persons are at risk of infection from either *S. mansoni* or *S. haematobium*. The prevalence rate for the country may be as high as 21 percent. Estimates of one million or more infected persons have been made for Sudan. There are approximately 35,500 infected persons in Morocco and an estimated 700,000 in the Philippines.

High infection rates have been recorded in Ghana, particularly in the Lake Volta area, where prevalence of 100 percent has been reported in some areas. In the Congo, 65 percent of the population of 580,000 in the regions of Bouenza, Niari and Kouilou are estimated to be infected. Approximately 70 percent of the population of 150,000 persons in the Atlas and Gafsa mountain regions of Tunisia were found to be infected. Schistosomiasis is widespread in Mali, where prevalence rates as high as 70 percent or more have been reported from areas where control projects have been initiated. It is estimated that nearly 150,000 of the half million citizens of Swaziland are infected with one or more of the three endemic species of schistosomes.

b. Populations affected

Schistosomiasis is primarily a rural disease associated with daily activities related to water use, such as farming, fishing, bathing, recreation, washing clothes and kitchen utensils, and personal hygiene.

Irrigation and water resource development to improve agricultural productivity have changed the epidemiology in major endemic areas from seasonal and highly focal transmission to intense, widespread, constant transmission, particularly in the rural areas. Urban and peri-urban transmission of schistosomiasis is becoming a serious problem in developing countries. This is due, in part, to the migration of infected persons from the countryside to areas of the cities or their suburbs that do not have adequate sanitary and health care facilities. There is an urgent need for effective interventions at the first level of the urban health care delivery system. These interventions also should include efforts to identify transmission sites and eliminate them.

c. Child survival

With the exception of occasional massive infections with cercariae (Katayama syndrome), schistosomiasis is not considered a significant cause of death in children younger than five. However, primary infections are usually acquired early in life and the pathology associated with repeated exposure is cumulative. It is also difficult to estimate the role of schistosomiasis as a complicating factor in child deaths associated with other conditions such as malnutrition, malaria and diarrhea.

The prevalence of infection among children increases as they experience more contact with water infested with infected snails. As children grow older, they swim and play in canals and other water bodies and work in the fields, increasing their exposure to schistosome infection and reinfection.

The peak prevalence and intensity of *S. haematobium* infection usually occurs in children between the ages of 10 and 14. There is generally a decrease in prevalence and intensity of infection among older people who have less contact with water. Nearly 60 to 70 percent of those most heavily infected with *S. haematobium* are between five and 14 years of age.

The prevalence of infection for *S. mansoni* is generally highest in the 10 to 24-year-old age group. In contrast to *S. haematobium*, prevalence in older age groups usually remains at high levels. Most of the heavily infected persons are found in the 10-14 year-old age group. A high proportion of children with elevated egg counts (>800 eggs per gram of feces) have enlarged livers and spleens.

Infection rates for *S. japonicum* also persist in older age groups, rather than falling during the third decade of life, as they do with *S. haematobium*.

Complications reported to occur in children infected with schistosomiasis include physical weakness, reduced attention span and lowered learning potential.

Infection with schistosomiasis is a frequent cause of absenteeism among schoolchildren. It is common for 85 percent of a school's student population to be infected in some highly endemic areas in Africa.

d. Economic Impact

Schistosomiasis has a major impact on the agricultural workforce and national economic productivity. For example, in Egypt, where 20 percent of the people are infected, economic losses due to lost work are estimated to exceed $500 million a year.

3.0 Control Measures

Schistosomiasis control strategies have changed dramatically in recent years. The major emphasis has shifted away from elimination of infection or interruption of transmission toward control of the human disease with chemotherapy or possibly vaccines. Three new oral drugs have been developed that can be administered in short regimens with greater safety and higher efficacy previous anti-schistosomal compounds. In addition, two simple, inexpensive techniques that can be used to diagnose and rapidly estimate the severity of the infection have been developed.

Schistosomiasis is a disease that lends itself well to possible control through community-based and primary health care approaches. Some essential components of primary health programs such as health education, food and nutrition, water supply and sanitation, maternal and child health, and drug distribution can all be used to reduce the impact of schistosomiasis. This approach, however, will require a long-term commitment and effort by governmental officials of the affected countries and donor organizations.

a. Chemotherapy

The history of chemotherapy of schistosomiasis has been marked by the introduction of a number of highly toxic drugs that were extremely dangerous to use in clinical treatment.

During the past two decades, there has been a steady introduction of new antischistosomal drugs. Only three of the drugs developed during the last 20 years are recommended by the World Health Organization (WHO) for treatment of human schistosomiasis: metrifonate, oxamniquine and praziquantel.

Metrifonate is effective only against *S. haematobium*. Tolerance of the drug is good. Since metrifonate is related to organophosphorus insecticides, some mild, transient nervous system reactions have been reported, but these are rarely observed. No mutagenic, carcinogenic or teratogenic properties have been reported. Cure rates in control programs range from 40 to 80 percent. Even individuals who are not cured usually experience approximately a 90 percent reduction in egg counts. Metrifonate is inexpensive, but the treatment schedule of three doses given at two-week intervals is often difficult for patients to meet.

Oxamniquine is active only against *S. mansoni* infection. Patients infected with South American and African strains of *S. mansoni* show distinctly different responses to treatment with oxamniquine. The drug is usually well tolerated, especially when given after meals. Dizziness, drowsiness, headaches, and even hallucinations and convulsions have been observed in a small number of patients.

Cure rates of 60 to 90 percent can be expected after the appropriate therapeutic dose of oxamniquine has been administered. Even in persons who are not completely cured, a reduction in egg excretion of 80 to 90 percent is common. This drug has been used to treat several million persons. It is relatively expensive (US $2.00/dose).

Praziquantel, a one-dose oral medication effective against all species of schistosome except *S. japonicum*, was introduced in the early 1980s and is now the primary tool for controlling schistosomiasis. No mutagenic, carcinogenic, embryotoxic or teratogenic activity has been reported for this compound, and it is well tolerated. Side effects include abdominal discomfort, diarrhea, dizziness and sleepiness. Less frequent episodes of fever and skin rash have been reported. Through the efforts of WHO and the World Bank, the high cost of this drug has been reduced from $12 to less than one dollar per course of treatment.

Praziquantel's cure rate in the field is between 80 to 90 percent for *S. haematobium*. Reduction in egg excretion for those who are not cured is approximately 90 to 95 percent one year after therapy. For *S. mansoni* infections, a cure rate of 60 percent is reported one year after treatment and a 95 percent reduction in egg excretion for those who are not cured. More than one million people have been treated with this drug.

b. Surveillance and diagnosis

Given the cost and toxicity of available chemotherapeutic agents for schistosomiasis, most national programs recommend treating only diagnosed cases. Diagnostic techniques most widely used are designed to detect and quantify the number of eggs in urine or stool. Several good techniques for identifying infected individuals, such as the Modified Bell Urine filtration method and the Kato-Katz cellophane/malachite green/glycerine technique, have stood the test of time. However, these techniques are labor-intensive and subject to some variation in their interpretation. Moreover, there is some disagreement between experts about the relationships between the numbers of excreted eggs and the medical condition of the patient. Until more reliable immunological tests are developed, however, direct examination of excreta will remain the most useful method for identifying people in need of treatment and sorting out the epidemiological determinants of infection.

The evaluation of the clinical condition of individuals infected with schistosomiasis depends upon physical examination and invasive techniques such as rectal biopsy and esophageal enteroscopic examination. Some complex x-ray and laboratory tests, such as intravenous pyelography and renal clearance exams, can be helpful in assessing the condition and progress of individual patients, but are not practical for mass treatment campaigns. One procedure that is growing in its utility for community assessment is ultrasonography. This non-invasive technique may be used to differentiate between mild and severe cases of schistosomiasis in the near future.

c. Control of intermediate hosts

Methods for snail control fall into three general categories: chemical control, biological control, and environmental control. Until 1970, snail host control with molluscicides was the primary method used. Today, in most areas where schistosomiasis is highly endemic, snail host control can best be viewed as a supportive element in integrated control activities.

Chemical molluscicides

There is only one chemical molluscicide, Bayluscide, acceptable for use in snail control programs. However, at a cost of up to $10,000/ton, it is used only sparingly in local control programs. Copper sulfate, which was the standard molluscicide for more than 30 years, is no longer acceptable due to its high cost and unacceptable environmental effects.

Results of control projects conducted during the past decade in Brazil, Egypt, Jordan, Philippines, St. Lucia, Madagascar, Zimbabwe, Tanzania, Ghana and the Congo, among others, have demonstrated that snail control using molluscicides in combination with other methods can reduce and in some instances eliminate transmission. It is doubtful, however, that a program based on chemical snail control alone would be sustainable and effective.

Plant molluscicides

The most promising natural plant molluscicides are certain strains of *Phytolacca dodecandra* (Endod) and *Jatropha curcas*. These plants produce saponins, common wetting agents in detergents that are also toxic to snails. Up to this time, their use has been limited to experimental trials due to the lack of long-term toxicological studies, which must be done before they can be used operationally.

Biological control

Biological control has long had a wide appeal as a possible control option. Examples of potential biological control mechanisms include snail antagonists and competitors, snail predators and pathogens.

Recent interest has focused on the ability of snails that are not intermediate hosts of schistosomiasis to out-compete vector snails within their own environment. Certainly under laboratory and controlled field conditions, species of freshwater pulmonate snails such as *Heliosoma duryi* and *Marisa cornuarietis* have been able to replace *Biompholaria* sp. and *Bulinus* sp., respectively.

Some species of water fowl and fish such as *Astatoreschromis alluadi* have been shown to feed on snails or their eggs. There is little specificity to the feeding habits of these predators, but reductions of snail populations have been measured under controlled field conditions. Other possibilities include the use of insect larvae and even leeches as predators against the snail intermediate hosts.

Another interesting area in biological control is the use of parasites known to reduce the fecundity of snails. Some degree of priority should be given to studies using *Echinostomum malayanum* and *Ribeirroia marini* as possible control organisms.

The question of controlling intermediate host snails with biological organisms is a fascinating one, but there are no examples of control programs based upon biological control. There are legitimate environmental concerns associated with the introduction of exotic species of organisms into field conditions where their fate and ultimate ecological niche are unknown. Therefore, research on biological control must proceed with caution and adequate safeguards.

Environmental control

Environmental modification to reduce snail populations and human contact with snail-infested water can be an important component of a schistosomiasis control program. Practical approaches that have proved effective include building bridges to eliminate fording and fencing off areas where children come into contact with contaminated water.

The physical removal of intermediate host snails from canals and water courses with dredges and scoops is commonly practiced in Egypt and Sudan. Of course this method is labor-intensive and carries a high risk to those involved in the dredging process. Lining canals with cement and removing vegetation from waterways deprives the snails of food, but the foreign exchange and labor costs of this approach make it impractical in most cases. Filters and screens to trap snails have been given limited trials. In most water systems, these physical barriers become clogged with debris and vegetation and require constant maintenance.

Where water quantity is not a limiting factor, raising and lowering water levels and increasing flow rates can be used to disturb snail habitats and their food sources. Unfortunately, the circumstances under which these methods can be used are few.

d. Health education

Health education and mass media campaigns to discourage contamination of snail habitats with human waste are perhaps the most effective and sustainable measures for limiting schistosomiasis transmission. Ultimately, these approaches will have the desired effect, but behavioral change is difficult and requires time and patience.

e. Vaccine

The ultimate control intervention would be preventing infection through immunization. Advances and technological breakthroughs resulting from immunological research on malaria and AIDS have given rise to considerable optimism that prevention of schistosomiasis through vaccines may be possible. At this time, however, there is no inoculation to protect humans against schistosomiasis infection.

f. Constraints to control

Technical constraints

The current schistosomiasis control strategy is to use population-based chemotherapy to reduce morbidity to a level at which the more serious pathological changes associated with advanced schistosomiasis are unlikely to occur. Because of costs, incomplete cures and concerns about toxic side effects, there is a need to continue the search for safer, more effective drugs. More appropriate regimens and delivery systems, as well as lower-cost drugs in plentiful supply, are the eventual goals.

A very serious potential problem in schistosomiasis therapy is the emerging problem of drug resistance. Resistance of *S. mansoni* to oxamniquine has been observed in Brazil and Kenya. Preliminary results from Kenya also indicate that *S. haematobium* resistance to metrifonate is occurring. There is every reason to suspect that resistance is occurring in other countries where mass treatment campaigns have used anti-schistosome agents such as niridazole, hycanthone and oxamniquine.

There have been recent reports of reduced efficacy of praziquantel in the treatment of schistosomiasis. It is not clear at this point whether this represents tolerance or true resistance. However, continuous monitoring for resistance should be an international priority and every step should be taken to use this resource wisely to protect efficacy for as long as possible.

Chemical or physical control of the intermediate host snails of schistosomiasis can be extremely effective, but the techniques and methods available are labor-intensive and costly. Their effective use also requires a firm long-term commitment for manpower and commodities. For most countries with endemic schistosomiasis, the cost of the standard molluscicide Bayluscide in foreign exchange is too high except when schistosomiasis is extremely focal and has a strong impact upon sectors other than health. The use of living organisms to control schistosome intermediate host snails is a theoretical possibility that has never been fully exploited in operational control programs.

Current approaches to the control of schistosomiasis stress the need for multifaceted, integrated methodologies. National control programs based upon only one intervention such as chemotherapy or molluscicides have little chance of sustained success.

Human resource constraints

Many of the tasks necessary for schistosomiasis control programs can be carried out satisfactorily with relatively unskilled manpower. This is particularly true for molluscicide delivery systems. The recently developed parasitological techniques for urine and stool examinations can be used by relatively unskilled workers, who also can be instructed in other aspects of control programs, such as collecting and counting snails, physical control tasks and community education.

One major constraint is the lack of skilled people needed to carry out database management and other research tasks, fill intermediate and top-level supervisory positions, and train control personnel. Projections of the number of people needed in each skill category have not been established in many endemic countries. Despite the funds agencies have provided for training, there is still a critical shortage of technical and professional personnel.

Economic constraints

Funds provided by bilateral agencies such as A.I.D. and GTZ, the UNDP/World Bank/WHO programs, and other international organizations have enabled scientists to conduct goal-oriented research to develop new tools and strategies for use in control programs. The use of these tools and strategies in country-wide programs is often prohibitively expensive. Therefore, more emphasis must be placed on community participation, use of indigenous resources and in-country training as part of long-term control programs.

There is no question that the cost of effective schistosomiasis control can rarely be covered by the overtaxed and usually underfunded health sector budget. The shortfall is often met by external agencies willing to provide resources to demonstrate the effectiveness of various control options. However, the sustainability of this approach is highly questionable.

The increases in schistosomiasis that have been observed in many developing countries are often linked to development activities, such as irrigated agriculture, new land use and expanded fishing and dam building. A policy question for the next decade would be how to effectively link the costs of schistosomiasis control to the development activity rather than to depend upon beleaguered health ministries to meet the costs from their own budgets.

4.0 Current Research

a. Chemotherapy

Phase I clinical trials of amoscanate, a drug that is active against all species of schistosomes, have been completed in the United States. RO.13-3978, another antischistosomal drug, is being tested in the laboratory. There is very little support for the development of new antischistosomal drugs because they are not profitable on the world market and because of the effectiveness of praziquantel.

b. Vaccine

The development of a schistosomiasis vaccine is an area of active biomedical research. Despite considerable technical progress, however, there is no vaccine on the horizon.

c. Egyptian Schistosomiasis Research Project

In Egypt, which suffers the highest per capita impact from schistosomiasis, A.I.D. has initiated a comprehensive 10-year program to focus the research efforts of teams of Egyptian and U.S. scientists on virtually all aspects of the problem. This program should be watched closely for the development of vaccines, new diagnostic and drugs, innovative approaches to snail control and socioeconomic approaches to reducing transmission and disease impact.

5.0 Schistosomiasis from the A.I.D. Perspective

Schistosomiasis occurs in 47 A.I.D.-assisted countries. The number of infected persons living in these countries probably exceeds 125 million. The number of persons at risk of exposure could be higher than 300 million.

Despite the lack of demonstrable mortality due to schistosomiasis, the disease is a priority problem for the health ministries of 45 A.I.D.-assisted countries. Current Agency health sector emphasis on child survival tends to relegate schistosomiasis to a lower priority because it causes little detectable morbidity and almost no mortality in preschool-age children. However, initial infections are commonly acquired by children younger than five through behaviors that will lead them into repeated infection throughout their lives, affecting their learning potential, school attendance and productivity, and predisposing them to chronic health problems in later years.

It is the inextricable link between the transmission of schistosomiasis and development activities that should be of most concern to the Agency and its Missions. Here lies not only the opportunity to do good, but also the possibility of causing real harm. A.I.D. has led the field in raising consciousness about environmental issues, developing guidelines for pesticides and other toxic substances, and improving the quality of life of rural people. Equal care must be exercised in promoting activities that cause the spread of schistosomiasis. The disease is preventable, but the responsibility lies in development planning, not in remedial actions by the health sector. The costs of prevention should be borne by the development budget, not passed along to an already overburdened Ministry of Health.

A.I.D. traditionally has been involved in schistosomiasis control in countries where the per capita impact of the disease is high, including Egypt, Sudan and Cameroon. Much has been learned from those efforts, not only about alleviating disease, but also about more effective development. Agency emphasis should be on benefiting from the lessons that have been learned.

a. The Horizon

The next 10 years will bring many technological advances in effective drug treatment, improved diagnostics to identify those most in need of medical help, more efficient mechanisms for snail control, and perhaps vaccines to protect children from infection. However, some of the most useful advances could come from the social sector. Better understanding of the socio-economic factors that place some people at greater risk of infection than others would provide a basis for more effective health education, occupational safety and rational prevention strategies.

A.I.D.'s development partners such as WHO and the World Bank have targeted increasing the availability and lowering the cost of praziquantel and other effective pharmaceuticals as a prime objective. This undoubtedly will have a high payoff in the short run. But few experts have hopes for long-term benefits from such a single-intervention strategy because treatment of infected individuals will have little effect on reinfection. In addition, all other anti-schistosomiasis drugs have suffered eventual loss of efficacy as the parasites developed resistance to them.

The Agency has taken the lead in finding new approaches to schistosomiasis control through a new applied schistosomiasis research program in Egypt. It is the most comprehensive control-oriented research activity ever attempted and will bring the combined scientific abilities of the Egyptian and U.S. research communities to bear on the development of vaccines, immuno-diagnostics, new drugs, methods of snail control and socio-economic factors related to transmission control. Significant progress in controlling schistosomiasis can be expected during the next decade if A.I.D. and other development organizations actively seek to employ these tools and strategies in the development planning process.

b. Priorities for future action

- Assisting governments in the development of national and regional control strategies. The emphasis should be on strengthening existing agricultural programs in the area of schistosomiasis control and expanding primary health and community-based programs in more effective health education and intervention strategies.

- Support for applied research, such as that provided through TDR and A.I.D.'s Office of the Science Advisor, for the development of new control tools, including FDA-approved vaccines and new drugs, and simple diagnostic screening procedures that will assist in targeting chemotherapeutic treatment. USAID/Cairo's new Schistosomiasis Research Project will be a continuing source of new ideas and interventions and should be monitored closely for the application of its findings to other countries.

- Continued support for regional centers that are committed to training personnel for improving surveillance and applying control methodologies to agricultural activities.

- Inclusion of schistosomiasis control as an obligatory environmental concern to be address by IEEs and EAs as part of the project planning process. This should be done not only to eliminate concern about negative environmental impact, but to identify opportunities for reducing the impact on existing levels of transmission.

- Supporting operational research to develop effective praziquantel distribution programs through schools and primary health care systems.

- Cooperating with the World Bank, WHO, the Peace Corps, and other agencies and organizations that give a high priority to schistosomiasis control. Particular emphasis should be placed on supporting complementary activities that will lead to multi-intervention strategies rather than putting all of the eggs into the chemotherapy basket.

- Seeking new mechanisms to support the cost of schistosomiasis control. Much of the transmission is linked to agriculture and other economically important activities. The budgets of those activities should be required to bear the cost of prevention instead of passing them along to the Ministries of Health, which are traditionally underfinanced. The private sector should be encouraged to support schistosomiasis control efforts to protect its workers and investments.

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Annex 1

Table 1. Geographical Distribution of Schistosomiasis by Species

Country or Area	S. mansoni	S. haematobium	S. intercalatum	S. japonicum	S. mekongi
Africa					
Algeria		+			
Angola	+	+			
Benin*	+	+			
Botswana*	+	+			
Burkina Faso*	+	+			
Burundi*	+				
Cameroon*	+	+	+		
C.A.R.*	+	+	+		
Chad*	+	+	+		
Congo*	+	+	+		
Ethiopia	+	+			
Gabon	+	+	+		
Gambia*	+	+			
Ghana*	+	+			
Guinea-Bissau*	+	+			
Guinea*	+	+			
Ivory Coast*	+	+			
Kenya*	+	+			
Liberia*	+	+			
Madagascar*	+	+			
Malawi*	+	+			
Mali*	+	+			

* A.I.D.-assisted countries

Table 1 (continued)

Country or Area	S. mansoni	S. haematobium	S. intercalatum	S. japonicum	S. mekongi
Mauritania*		+			
Mauritius*		+			
Mozambique*	+	+			
Namibia	+	+			
Niger*	+	+			
Nigeria*	+				
Rwanda*	+				
Sao Tome and Principe*			+		
Senegal*	+	+			
Sierra Leon	+	+			
Somalia*		+			
South Africa	+	+			
Sudan*	+	+			
Swaziland*	+	+			
Togo*	+	+			
Uganda*	+	+			
Tanzania*	+	+			
Zaire*	+	+	+		
Zambia*	+	+			
The Americas					
Antigua	+				
Brazil	+				
Dominican Republic*	+				
Guadeloupe	+				

Table 1 (continued)

Country or Area	*S. mansoni*	*S. haematobium*	*S. intercalatum*	*S. japonicum*	*S. mekongi*
Martinique	+				
Montserrat	+				
Puerto Rico	+				
Saint Lucia	+				
Suriname	+				
Venezuela	+				
Eastern Mediterranean and Europe					
Democratic Yemen	+	+			
Egypt*	+	+			
Iran Islamic		+			
Iraq		+			
Jordan*		+	(No recent transmission)		
Lebanon*		+			
Libyan Arab Jamahiriya	+	+			
Morocco*		+			
Oman*	+				
Portugal*		+			
Saudi Arabia	+	+			
Syrian Arab Republic			+		
Tunisia*		+			
Turkey*		+			
Yemen*	+	+			

Table 1 (continued)

Country or Area	*S. mansoni*	*S. haematobium*	*S. intercalatum*	*S. japonicum*	*S. mekongi*
Southeast Asia/ Far West					
China				+	
Democratic Kampuchea		+		+	+
India*		+			
Indonesia				+	
Japan				+	
Lao People's Dem. Republic					+
Malaysia*					+
Philippines*				+	
Thailand*					+